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Impact of a standard conduit fish counting fence on water quality of Campbellton River, 2001

Effets d'une barrière de dénombrement des poissons standard sur la qualité de l'eau de la rivière Campbellton en 2001

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Abstract

This study was undertaken to determine the impact of a standard portable fish counting fence and associated biological studies on water quality in Campbellton River. Two counting fences have been installed annually in this river since 1993, one, for counting adults, located at 160 m and the other, and the other for counting smolts, at 300 m from the community water intake for the town of Campbellton. Water samples were collected during the summer of 2001, at sites above and below the smolt and adult counting fences and just prior to and after the counting fences were installed. These samples were analyzed for selected heavy metals and basic bacteria levels. Also, added to this study is data from selected historical water quality samples taken by Department of Fisheries and Oceans or the Department of Environment in 1972, 1987, 1990, 1992, 1993, 1994 and 2000. The results indicated that there was no effect on water quality from the introduction of the counting fences or from related biological studies carried out for the Campbellton River.

Résumé

L'objectif de cette étude était de déterminer les effets d'une barrière de dénombrement des poissons portative standard et des études biologiques connexes sur la qualité de l'eau de la rivière Campbellton. Chaque année depuis 1993, deux barrières de dénombrement sont installées dans cette rivière : une première à 160 m de la prise d'eau de la ville de Campbellton pour dénombrer les adultes et une seconde à 300 m de cette prise d'eau pour dénombrer les saumoneaux. Au cours de l'été 2001, nous avons recueilli des échantillons d'eau à des endroits situés en amont et en aval de chacune des barrières de dénombrement tout juste avant ou après l'installation de celles-ci. Nous avons déterminé les teneurs en certains métaux lourds et les concentrations de bactéries de ces échantillons. De plus, nous avons analysé des données sur la qualité de certains échantillons d'eau recueillis par le ministère des Pêches et des Océans ou par le ministère de l'Environnement en 1972, 1987, 1990, 1992, 1993, 1994 et 2000. Nos résultats montrent que l'installation de barrières de dénombrement ou la réalisation d'études biologiques connexes dans la rivière Campbellton n'ont pas d'effet sur la qualité de l'eau.

Introduction

Portable fish counting fences of various designs have been used as a research tool for salmonid stock assessment in Newfoundland and Labrador rivers since 1951 (Blair 1956). In 1954 a counting fence of netting was introduced on the Little Codroy River to study Atlantic salmon (*Salmo salar*), that used 1.27 cm stretched mesh netting for smolt and 5.08 cm stretched mesh for the adult fence (Murray 1968). Since then more stable portable counting fences comprised of steel are being used. The first conduit and steel fence was introduced to the island by Department of Fisheries and Oceans at Western Arm Brook in 1971 (Anderson and McDonald 1978). Since then, portable steel counting fences have been used in many small and large rivers in the province. Presently, in this province, 10 rivers have portable counting fences installed yearly, including Campbellton River, which has had counting fences for the past nine years. Of the 10 rivers with counting fences in Newfoundland and Labrador, two serve as local community water supplies.

Campbellton River (Indian Arm River) flows in a north-easterly direction emptying into the sea at Indian Arm, Notre Dame Bay (Fig 1). The river is located in the Central Newfoundland Ecoregion characterised by gently rolling to hilly topography, underlain mainly by acidic bedrock with the absence of limestone (Damman 83). Campbellton River has a drainage area of approximately 296 km^2 with an axial length of 40.22 km with a mean width of 7.4 km (Porter et al. 1974). The drainage area is situated in a low relief basin on the north-east coast that generally has elevations less than 200 m, giving the river a moderate gradient when compared to rivers in other parts of Newfoundland. The Campbellton watershed is densely wooded, comprised mainly of black and white spruce with scattered patches of balsam fir and white birch, with string bogs that are mainly on the eastern side of the river. Throughout the waterway are many interlocking small lakes, some of which are quite shallow, with mean depths less than three meters. Habitat studies done at mid-summer during moderate water levels from 1993 to 1997 (DFO, unpublished data), indicate water flows through the system quite slowly at less than one meter per second. Salmonid rearing areas for both the fluvial and lacustrine habitats are 5,960 units (unit=100 m^2) and 4,037 ha respectively (Downton et al. 1998).

The protected water supply area was extended on October 12, 1999 from 7.15 km^2 of the lower section of the river to include the entire drainage basin. At present under the Environment Act, SN 1995 cE-13-1, Department of Environment and Labour of the Province of Newfoundland and Labrador, an approval must be obtained from the Province prior to any development activity in a protected public water supply. This only applies, if the development activity in the river is 100 m below or above the water intake. Campbellton River provides the town of Campbellton with its municipal water supply, except for the lower end of the community which draws it's water from local wells. Water is removed from the river by an infiltration gallery constructed in 1973 in the streambed just approximately 15

meters above tidewater. The water is then gravity fed into a culvert intake and pumped to a building located onshore several meters away for chlorinating (Fig. 2).

Three predominant man-made structures are located within the protected water supply area. One is the remains of a concrete dam (Horwood Dam) that was built in 1914 for a combined pulp mill and hydro plant. The dam extended 400 m and was constructed of 5,500 m^2 of concrete and ran along the river valley, 200 m up from the river mouth (Fig. 3). The structure collapsed in 1915 shortly after construction due to erosion under the dam by the river. When the dam broke, the resulting water runoff formed the east branch of the river, which is now the present location of the community water intake. Other structures on the river include the Michael's Harbour forestry resource bridge located 5.9 km upstream from the river mouth. The bridge was constructed in 1992 of steel and timber and extends approximately 30 m over the river. The main purpose of the bridge was to extend the Michael's Harbour Resource Road into new areas for forest harvesting. The Trans Canada Highway crosses over the river at two locations, Neyles Brook and Indian Arm Brook, just before they drain into Indian Arm Pond. Also, in the mid section of the river are scattered summer cabins with the main concentrated in the south-western end of Indian Arm Pond near the Trans Canada Highway.

Campbellton River has a healthy salmonid population and was designated as a Scheduled Salmon River in 1952. On average from 1993 to 2001, this river produced a downstream migration of 44,871 salmon smolts (*Salmo salar*) with an average upstream run of 3,108 adult salmon (Downton et al. 2000). These figures were derived from complete counts obtained from portable fish counting fences operating from early May to late September. Other fish species present in the system are ouananiche, brook trout, American smelt, American eel, arctic char and 3-spine sticklebacks. A commercial eel fishery takes place at several sites along the river.

Smolt and adult counting fences have been installed in Campbellton River since 1993 according to the description in Anderson and McDonald (1978). The smolt fence is placed across a 68 m section of the river, at a site just above the Old Horwood Dam, approximately 345 m upstream from the estuary and is installed by the first week in May. The smolt fence is made up of 40 sections, comprised of two lengths of steel channel iron (3.05 m) supported on each end by A-frames composed of two wooden legs and a steel pipe. Vertical pieces of 1.5 m EMT conduit pipe are inserted through the two lengths of channel iron approximately 100 cm apart to form a barrier to fish passage (Fig. 4). This part of the fence forms a "V" shape to guide fish into a trap. The trap is constructed of wood and plastic vexar netting and is placed at the base of the "V". The purpose of the fence is to trap fish above the structure and then channel them into the trap for enumeration but still allow the normal flow of water through the fence. The underlying river substrate for the smolt fence is comprised of bedrock with large and small boulders with minor amounts of loose gravel. This site was chosen because it has a fairly stable bottom with adequate water levels from May to early July for fish passage

into and out of the trap. The smolt fence takes approximately 4 to 5 days to install, depending on water levels at that time and crew size. Fence materials are either transported into the river on foot or with the aid of a small aluminum boat (no motor). Disturbance of bottom silt is minimal due to the method and short duration of the fence installation. During the smolt fence operation the trap was checked 5-6 times daily to release fish. Also, the fence is cleaned of debris daily as needed.

The adult fence is smaller but of similar construction as the smolt fence and located just below the Horwood Dam (Fig. 3). The river is approximately 25 m in width at the site of the adult fence. This fence is installed mainly on bedrock with the east wing over large and small boulders. The installation time is approximately three days with very little disturbance to the bottom substrate. The adult fence is generally in place by the beginning of June and remains in operation until late September. The period of time that the adult fence and smolt fence are in operation can overlap depending on the end of migration of downstream smolts with the beginning of upstream adults. Generally, the overlap between the two fences is less than a week. After the smolt run is finished the fence is removed from the river and stored on shore near the riverbank. The adult trap is 2.1 X 2.1 m and the sides are constructed of conduit pipe. The fence has two wings forming a V-shape into the trap and a guide wing to keep fish out of a pool located just above the west wing of the fence. Overall the fence is comprised of 20 sections. Inside the trap, a see-through enclosed tunnel is placed on the floor of the trap with an overhead underwater camera that will videotape fish as they pass through the fence. After use, the fences are completely removed from the river and stored on shore.

Generally, depending on the water height and bottom contour of the river, less than half the fence is submerged in the water during operation. A materiel list of the components used in the construction of a counting fence is presented in Table 1. The material list may change slightly depending on the site, however the major components would not change from river to river.

Similar to other water bodies on the island, bacterial levels for Total Coliforms and E. coli for Campbellton River are subject to seasonal variations and from year to year. Bacterial levels are influenced by pollution and rising water temperatures. On several occasions in the past, bacterial levels from Campbellton River have been high enough that boil orders were placed on the domestic water supply to the community by the Provincial Dept. of Health. There is a perception by some local people that the introduction of the two counting fences into this river has contributed to the bacterial levels. Either, directly by the counting fence or by having fish held for short periods of time above and below the fences depending on the fish migration direction. Therefore, the need to assess bacterial levels prior to and after fence installation.

Methods

Water samples were collected by Water Resources Management Division (Government of Newfoundland and Labrador) for Campbellton River in 1987, 1990 and 1994 near the water intake as part of a routine water sampling program for protected water supplies. Also in 1992, from May to November, during the construction phase of the Michael's Harbour forestry access bridge over the Campbellton River, 13 water samples were collected at chosen sites above and below the bridge and at the community water intake by Department of Environment. All the above samples were analysed at Water Analysis Laboratories in Mount Pearl, NL.

In 1993, 1 litre water samples were collected in conjunction with an electro-fishing study carried out in the latter part of August on Campbellton River by DFO. Collection sites were Indian Arm Brook just above the Trans Canada Highway, Neyles Brook below the highway and Indian Arm Tributary between Second and Third Pond (Fig. 1). In July of 2000, DFO collected similar water samples from the river at these three sites. All of these samples were analyzed at the Water Analysis Laboratory in Mount Pearl, NL.

In 2001, three water collection sites were selected, one located 50 m above the smolt fence, a second several meters below the fence and the third at the water intake for the community. The sampling site just below the fence was dropped after it was determined that the test results were very similar to those above the fence and at the intake. Both the smolt and adult fences were situated between these sample sites (Fig. 5). Water samples were collected as per techniques outlined by Shelton (1994). During each sampling period three, one litre water samples were collected at evenly spaced intervals between riverbanks for the upper site and three samples were taken near the intake for the lower site. All samples were immediately placed on ice and kept cool until transported to DFO laboratories in St. John's. Within 24 hours of arriving at DFO laboratories, the water samples were acidified with two ml of trace metal clean nitric acid. Without further processing, the water samples were then analyzed for a suite of elements by ICP-MS. Several other water quality parameters were done on site with a LaMotte Freshwater field testing kit (AQ-2). These samples were collected at a site in mid river just above the DFO field camp located near the mouth of the river. In total, water samples were collected from seven sites during the period from 1987 to 2001 with the furthest site from the counting fences at Neyles Brook, 22.3 km upstream from the mouth of the river.

To determine if the fence was affecting water quality, a two-factor Analyses of Variance (ANOVA) was applied to the ICP-MS data. The ANOVA tested for effects due to sampling date and location (above and below the counting fence).

Finally, Campbellton River water was tested for the presence of Total Coliform and E. coli (Escherichia coli) bacteria. Coliform bacteria are indicators of overall water

quality and efficacy of water treatment, where applicable, while E. coli bacteria are indicators of fecal contamination. E . coli is one bacteria found in large numbers in the gastro-intestinal tracts and faeces of warm-blooded animals and humans. The m-ColiBlue24 Broth PourRite Ampules method was used to determine Total Coliform and E. coli for these bacterial levels.

Water samples for bacteriological analysis were collected on six occasions from May to October 2001,above and below the fence site by DFO in sterile bottles provided by the district office of Government Service Centre in Lewisporte, and held at refrigeration temperatures (8 0^C) until tested. Testing occurred within 24 hours of collection, and followed the standard test methods appropriate for membrane filtration using m-Coliblue24 broth1. One hundred ml of each water sample was filtered through individual 0.45 mm pore-size Millipore filter papers, which were then incubated at 35 ± 0.5 0^C for 24 ± 4 hours in m-Coliblue24 broth. Following incubation, bacterial colonies on the filter papers were visually counted and classed according to colour: red colonies = coliform bacteria, blue colonies = E. coli bacteria, red colonies + blue colonies = total coliform bacteria. Prior to July of 2001, all colonies were counted, but after June of 2001, any samples with more than 80 colonies were noted as ">80". This change in methodology was made as a result of recommendations from the Public Health Laboratory at the Miller Centre, St. John's, NL.

Results and Discussion

Water Chemistry

Water chemistry results collected for selected years from 1973 to 2001 at Campbellton River are presented in tables 2 to 5, and show little variation over the last 24 years for colour, pH, specific conductance, turbidity, total dissolved solids and total hardness as well for other common parameters tested. Also, when these water quality results from tables 2 to 5 are compared to collections done by DFO in other rivers in Notre Dame Bay taken during 1972 and 1973 (Jamieson 1974) the results are very similar (Table 6). Therefore it can be concluded that water quality in Campbellton River has remained very stable over the last 25 years, and has shown little deviation from the results of nearby rivers. Based on these water quality results Campbellton River is not considered detrimental to aquatic life or humans.

Seasonal trends were observed in the water chemistry data (Fig. 6). Concentrations of Mg, Na, K, Ca, Mn, As, Li, and Sr increased as spring progressed into summer, while Al, Si, and Fe decreased over the same time period. These trends appeared to be related to water levels in the Campbellton River (Fig. 7 & 8). Cameron (1996) attributed similar trends in the Fraser River to the phase in which the constituents were found. Concentrations of elements in the dissolved phase increased as water levels dropped (spring to summer) whereas

the concentration of elements in the suspended or particulate phase decreased as water levels dropped.

The results from the ANOVA, therefore, revealed a significant difference ($p<0.05$) among sampling dates for the constituents mentioned above. However, after accounting for differences in sampling dates, there were no significant differences ($p>0.05$) detected, for any of the constituents measured, between sites above and below the counting fence (Table 6).

The water chemistry values collected for this study for 2001 indicate a very good agreement with the historical data (Tables 2 to 5). Conversion factors are 1000ug/L = 1mg/L = 1 ppm). This suggests that the water chemistry of the Campbellton River has changed very little over the past 25 years. This analysis indicates, that the installation and operation of the counting fence for the past nine years has not had any effect on the water quality. All parameters measured are well within the acceptable limits set by the Canadian water quality guidelines (Table 7) (Canadian Council of Ministers of the Environment 2001).

The above results are not unexpected. The components that make up the counting fence as indicated in Table 1 for Campbellton River would not be expected to chemically alter water quality in a river since all components are in a stable state. The Material Safety Data Sheets (MSDS) of major components are referenced in Appendix 1(a,b&c). Any leaching of elements from these manufactured components once submerged in freshwater is minimal and would present themselves at such low concentrations due to the high volume of water passing through the fence. Furthermore, the high volume of water passing through the fence would prevent any accumulation of material. Steel products used in this counting fence are in their solid form and do not present a hazard by inhalation, ingestion or contact as indicated from the material safety data sheet for these products (Appendix 1 b&c). Also, the Vexar screening is non toxic in the solid state (appendix 1a). The plastic and metals only pose a hazard if altered by burning, grinding or oxidation with strong acids. The rock and wood used in the fence construction are natural occurring materials that can be found in or around the river.

Bacterial Collection

While the Coliblue method allows for the quantification of bacterial colonies, the U.S. Environmental Protection Agency (EPA) has only approved this method for presence-absence type testing. This is partly due to the high rate of false positives (27% for total coliforms and 3% for E. coli) associated with this test. In addition, the American Water Works Association (AWWA 1998) has stated that the 95% confidence limits for membrane filter coliform results can be wide. Therefore, these results can only be used to make general comments about the bacteriological quality of the water tested, and cannot be used as precise measurements of bacteriological changes in the river.

Keeping these testing limitations in mind, the results of the water sample testing from the Campbellton River in 2001 show very little change between bacterial levels upstream and downstream from the counting fence (Table 9). Also bacterial levels compared during the fence operation to when the fences were not in the river suggest bacteria naturally occurs in the river. The general trend of increased numbers of bacteria from May to October is consistent with their seasonal variation, due to rising temperatures in the water (Fig. 7). The maximum daily temperature from May to September in Campbellton River was greater than 20 ^{0}C for 69 days and on 6 days the temperature exceeded 25 ^{0}C. These high temperatures corresponded with low water levels as indicated in Figure 8. The lowest flows on this river generally occur in late summer, when precipitation is low, evaporation and consumption by plants is high in conjunction with high, and water temperatures. Due to accelerated bacterial levels in the river a boil order was issued for the drinking water for Campbellton for most of the summer.

Conclusion

It is concluded from this study that the installation and operation of salmonid counting fences by DFO on Campbellton River over the past 9 years have had no apparent effect on water quality. Water quality on the Campbellton River is good and has not changed in the past several decades. The presence of bacteria in the water during the summer of 2001 is naturally occurring and common among all rivers. It would be expected from the results of this study that counting fences of similar construction installed in similar rivers of this province should have no affect on water quality.

Acknowledgements

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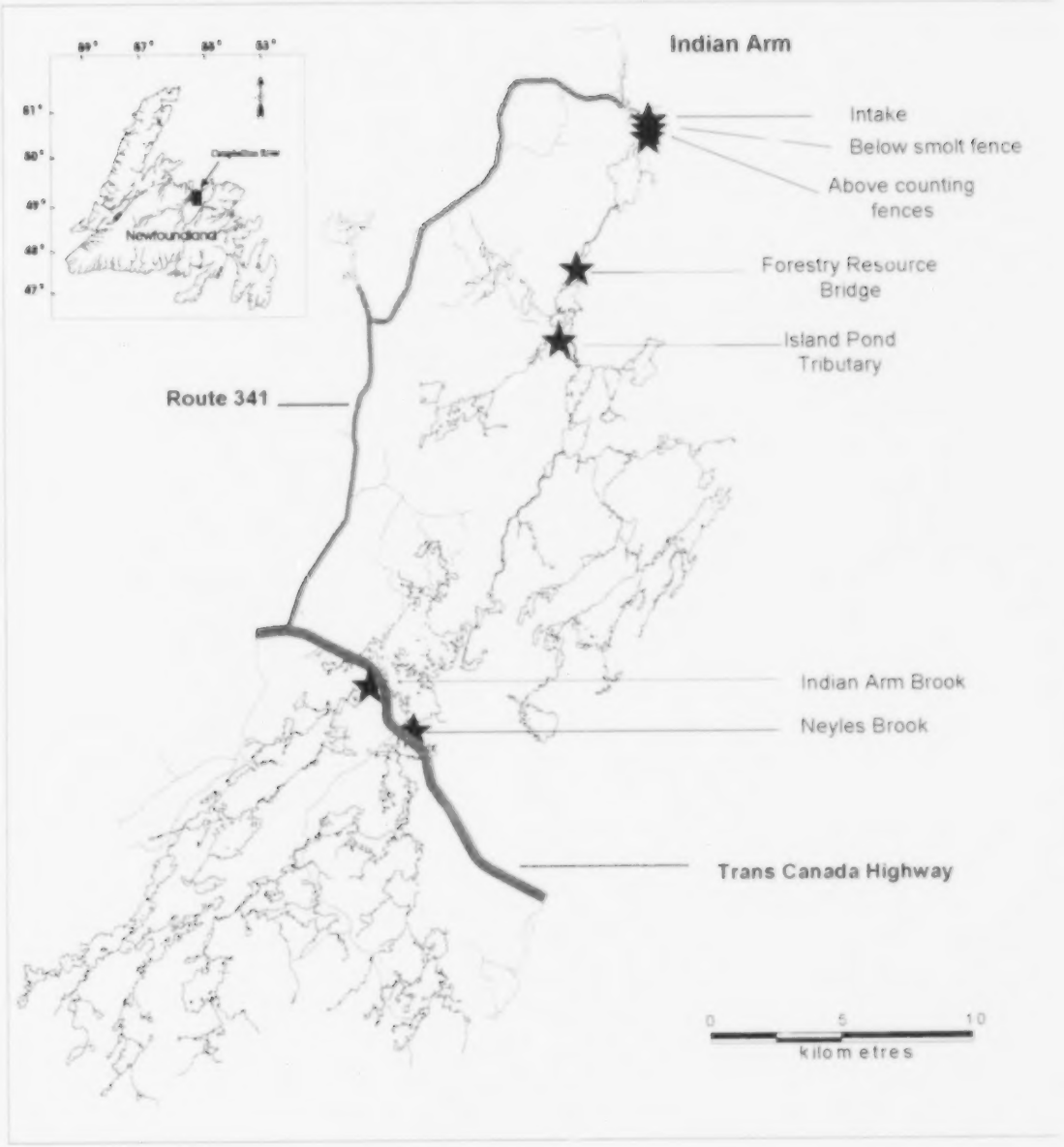


Figure 1. Water collection sites for Campbellton River from selected years from 1987 to 2001.

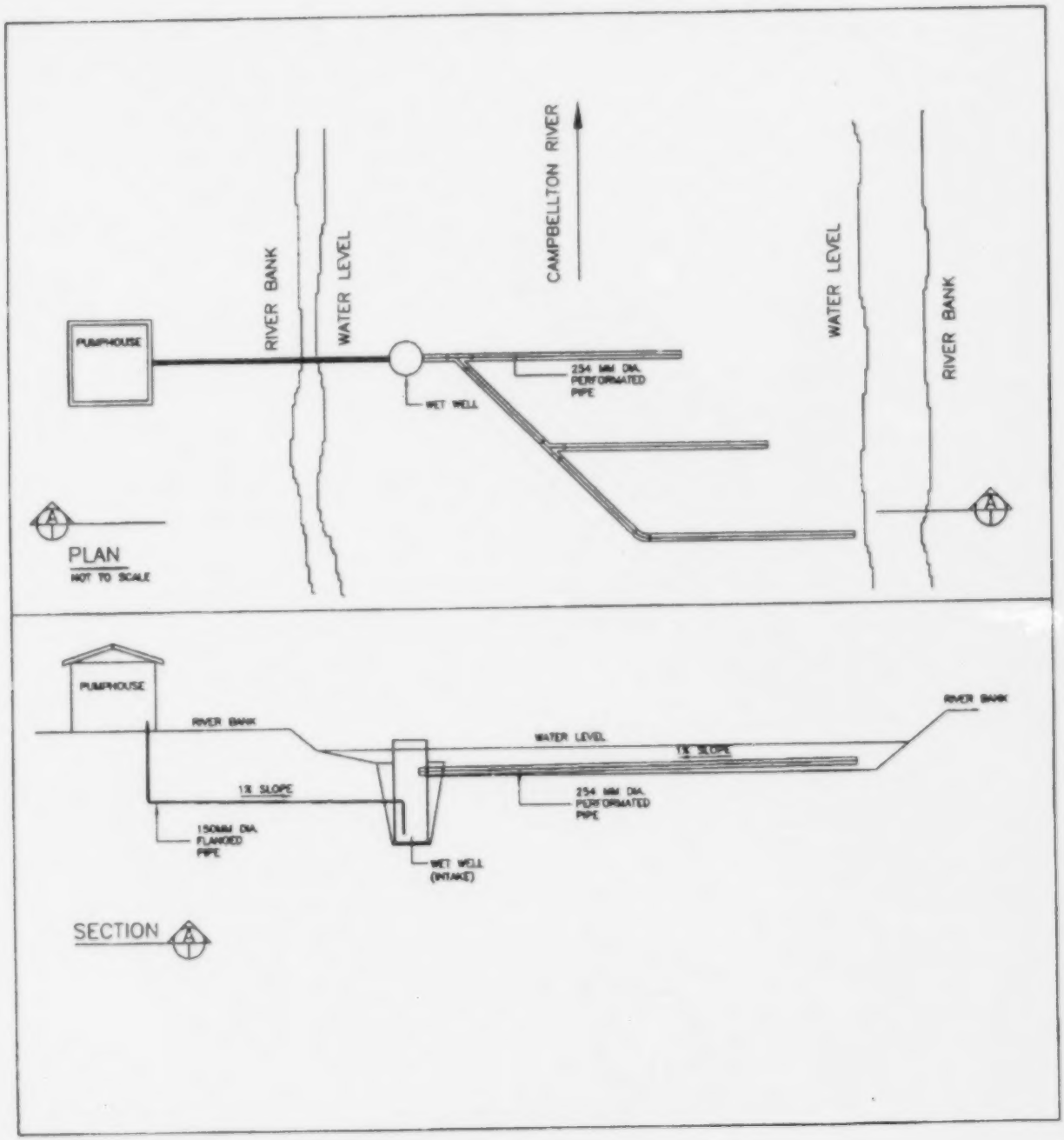


Fig. 2. Plan and section view of the intake at Campbellton River which supplies water to the Commmunity of Campbellton.

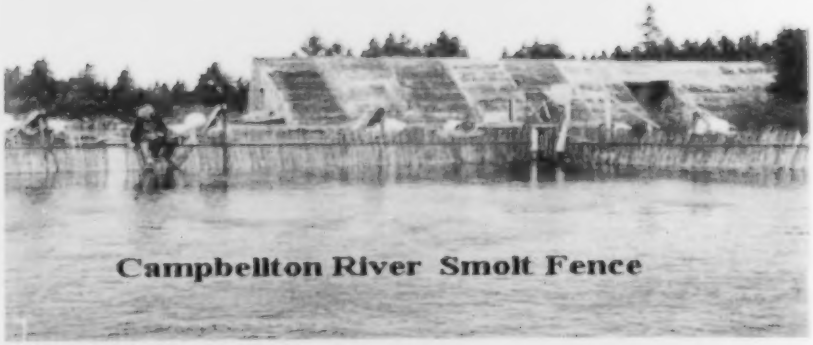


Figure 3. Adult and smolt counting fences used in Campbellton River.

Campbellton River Smolt Fence

Campbellton River Adult Fence

Figure 3. Adult and smolt counting fences used in Campbellton River

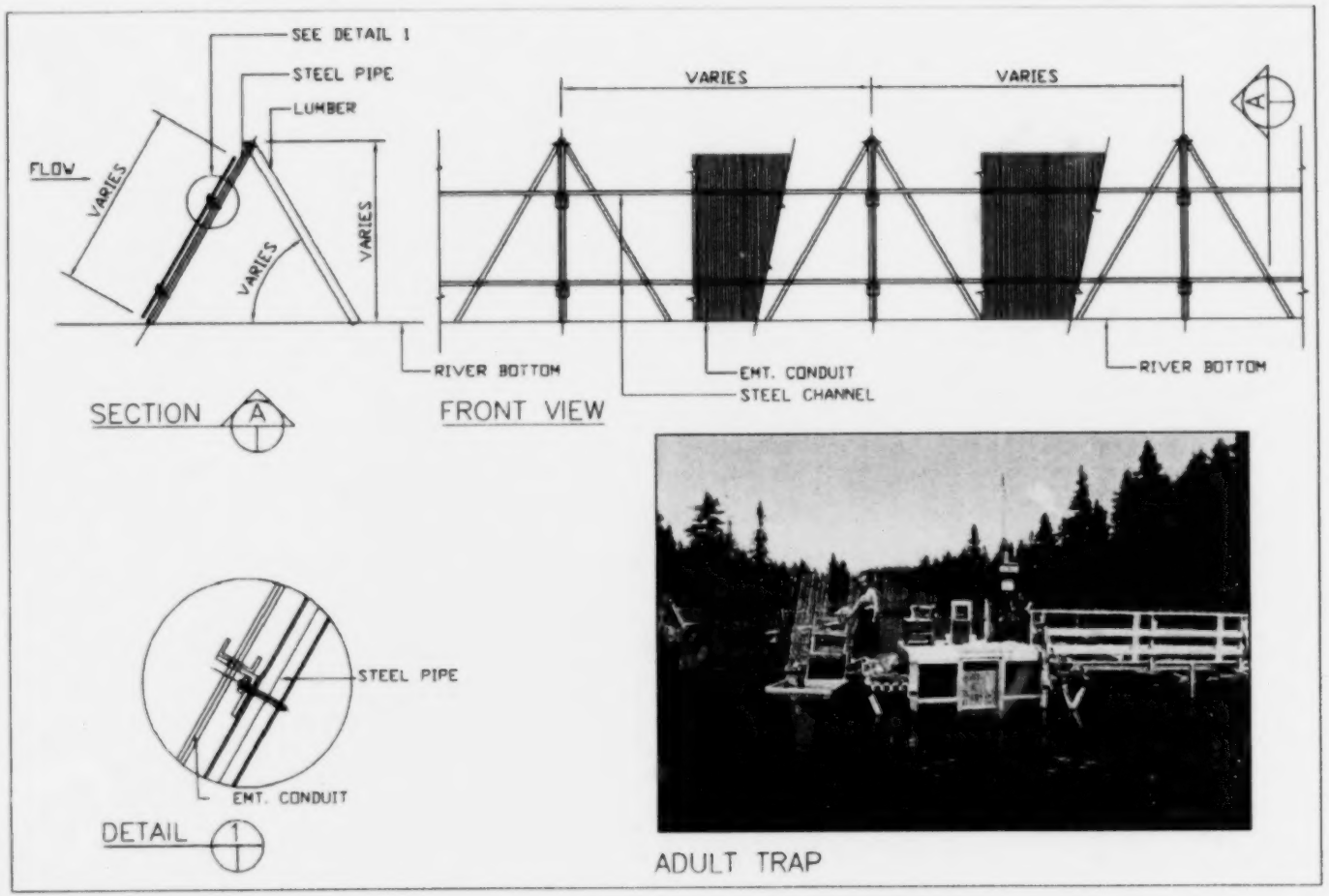


Fig. 4. Basic components which comprise the fish counting fence at Campbellton River.

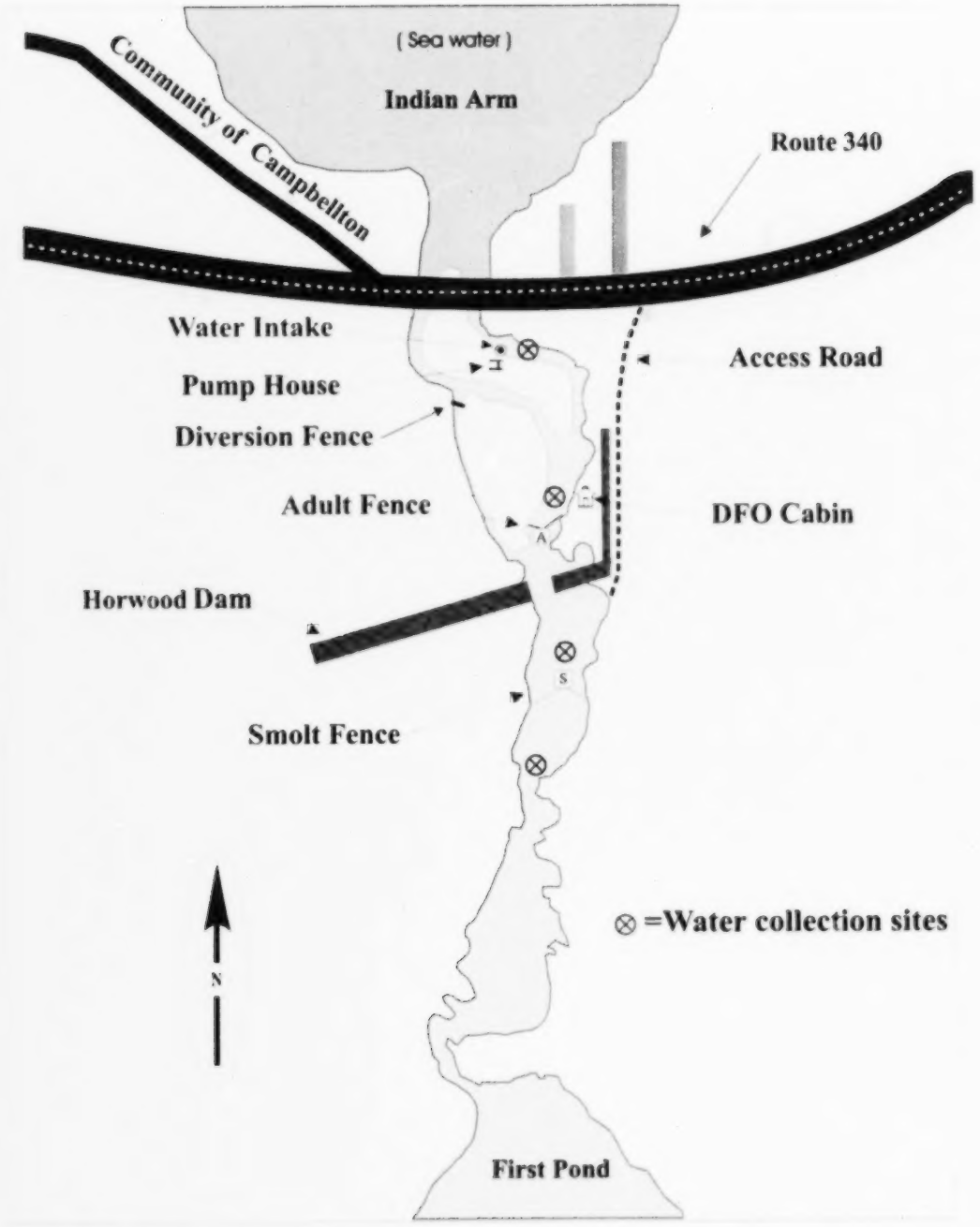
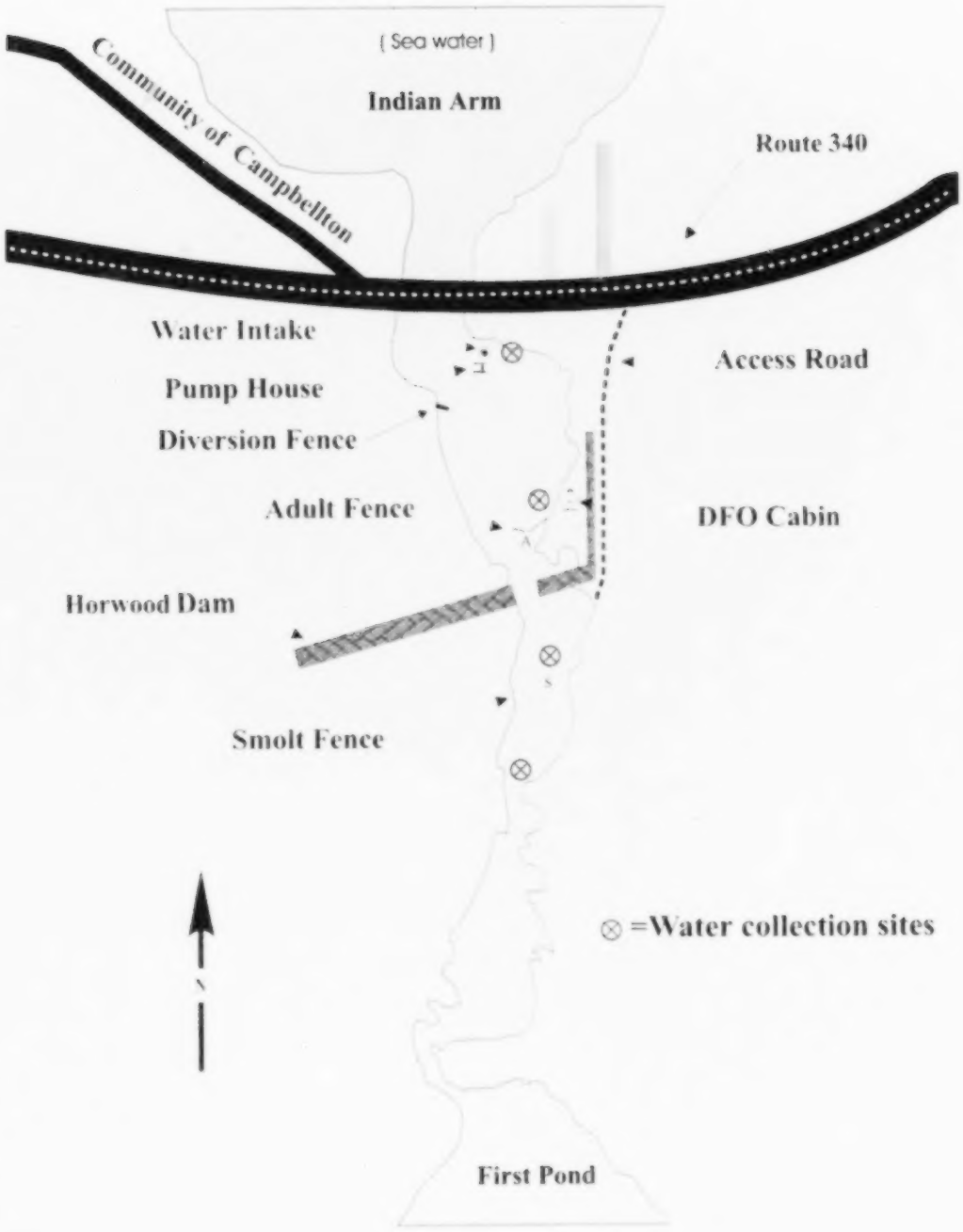


Figure 5. Locations of smolt and adult counting fences showing water collection sites for Campbellton River, 2001.



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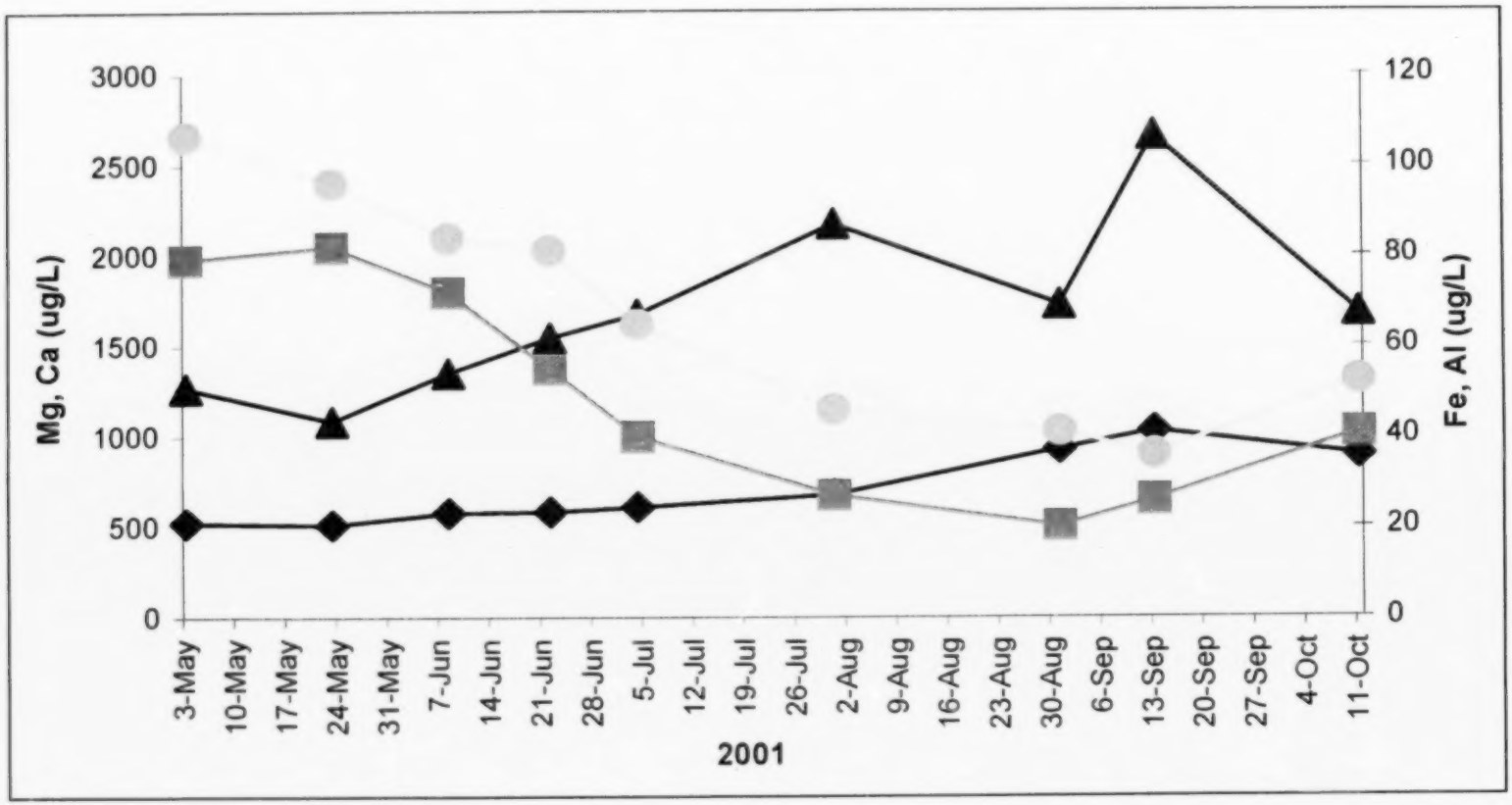

Figure 6. Average concentrations of Mg (diamonds), Ca (triangles), Fe (circles) and Al (squares) in Campbellton River water, 2001.

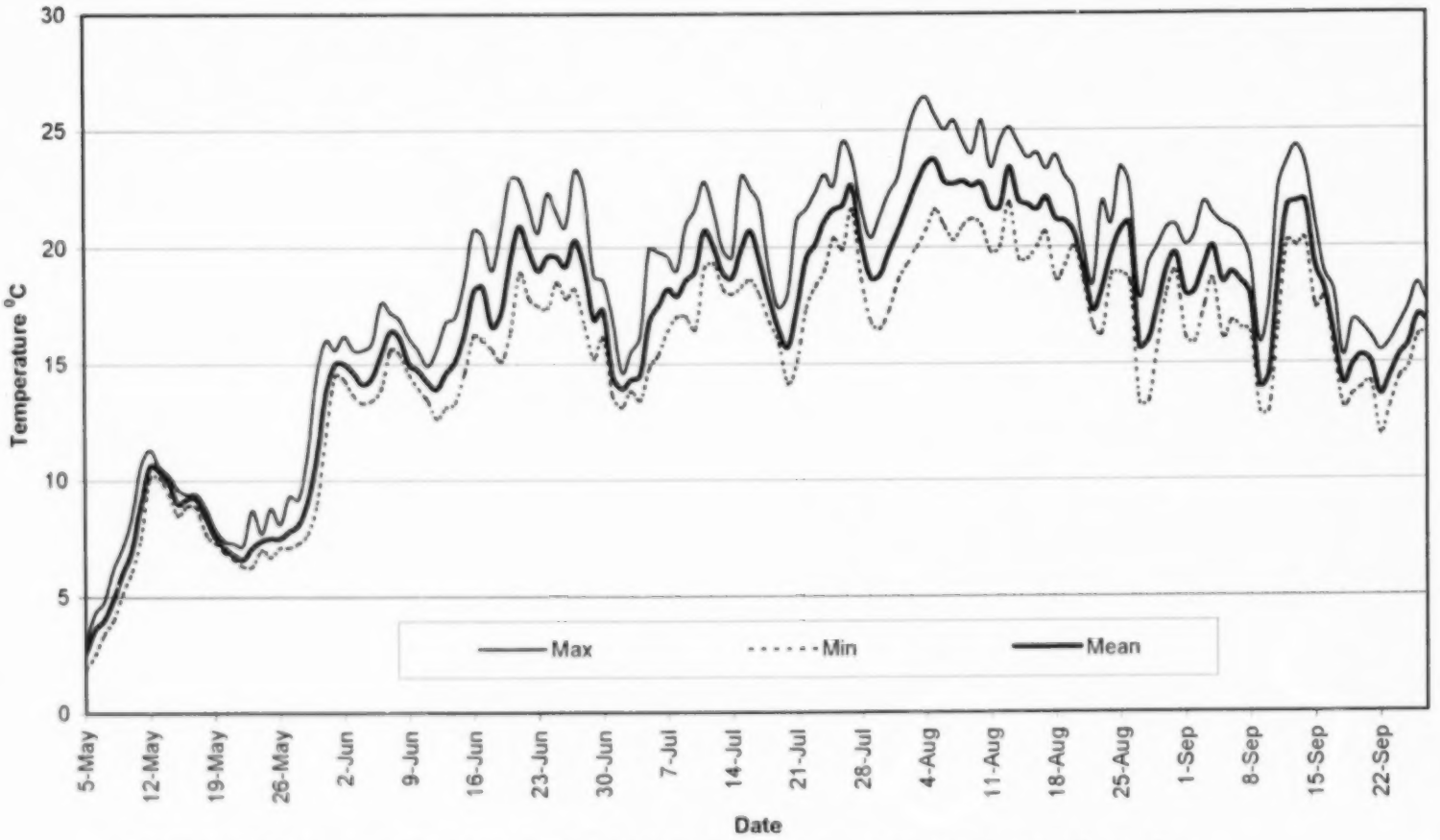

Figure 7. Water temperatures recorded at 1 meter depth near the adult counting fence for Campbellton River, 2001.

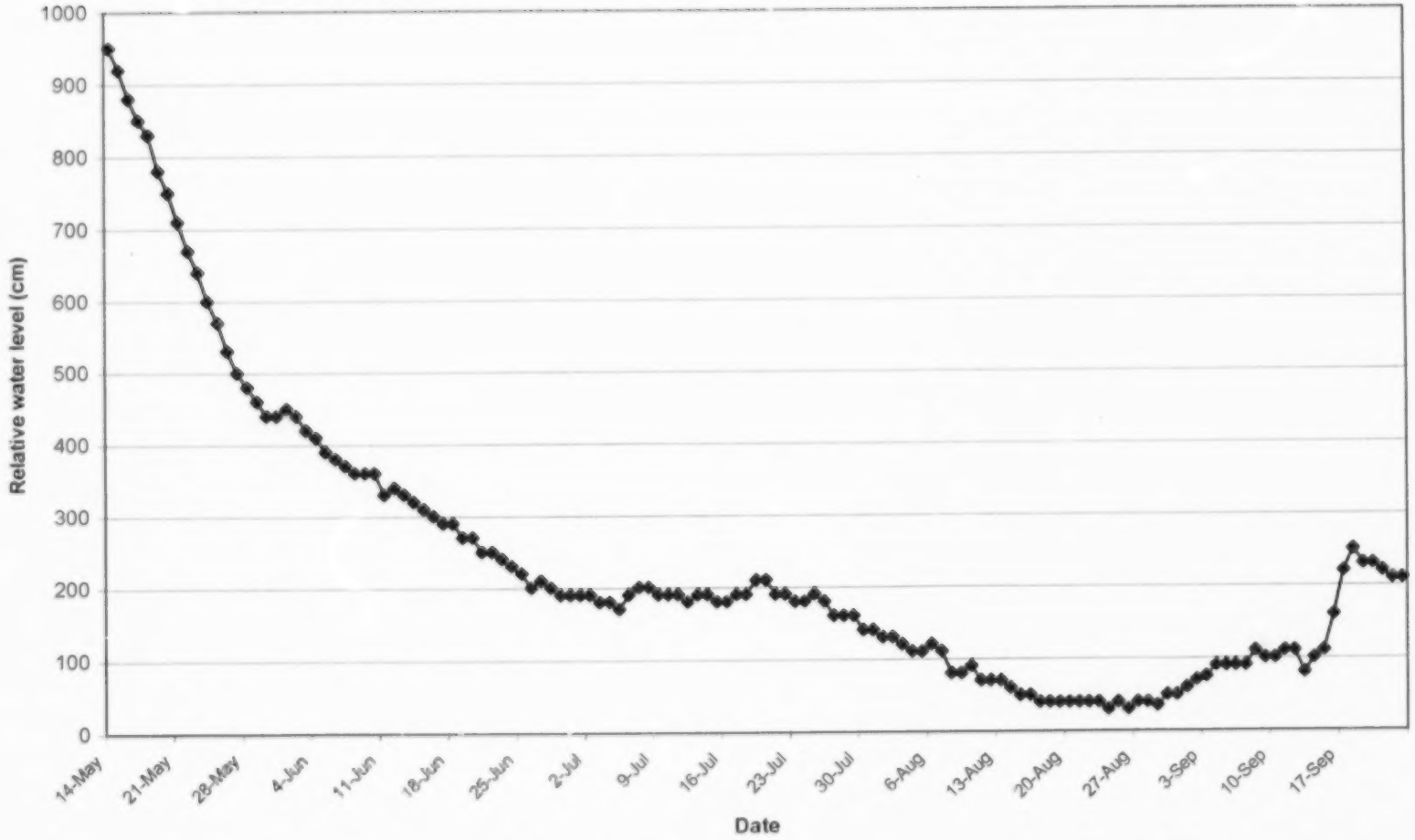

Figure 8. Relative water levels taken near the adult counting fence at Campbellton River, 2001.

Table 1. Material, quantity and their composition (MSDS) that would be used to erect 25 lengths of conduit counting fence.

Item	Description	Materiel for 25 lengths of fence	Item composition (as per MSDS if available)
Conduit 1/2" EMT	Zinc plated carbon steel tubing	3,990 m	Low-carbon steel and electrogalvanized with Zinc (Iron=93%, Mangenese=0.95%, Nickel=0.0005%, Chromium=0.001%, and Zinc=3.0%)
Wood (support legs)	(5.08 X 10.8 cm) X 2.44 m	52 pieces	Spruce or Balsam Fir trees
Wood (ballast platforms)	(5.08 X 10.8 cm) X 3.05 m	52 pieces	Spruce or Balsam Fir trees
Nails	8.89 cm common wire	12 kg	Steel
Channel irons	(3"x1 3/8 x 1/4 (9' 10" long)	40 lengths	Low alloy carbon steel MSDS=(Iron 99%, Carbon 1%, Manganese 2% Silicone 0.5% Chromium 0.5 % and Residual elements 2%).
Support pipe	5.08cm wide nominal XS (2.03m long)	26 lengths	Low alloy carbon steel MSDS=(Iron 99%, Carbon 1%, Manganese 2% . Silicone 0.5% Chromium 0.5 % and Residual elements 2%).
Ballast	6 to 10 kg rocks (75 kg per platform)	1,950 kg	Rock from the area
Angle iron	8.89 x 8.89 x 0.95 cm	52 units	Low alloy carbon steel MSDS=(Iron 99%, Carbon 1%, Manganese 2% Silicone 0.5% Chromium 0.5 % and Residual elements 2%).
U-Bolts	1.11 cm	52 units	Low alloy carbon steel MSDS=(Iron 99%, Carbon 1%, Manganese 2% Silicone 0.5% Chromium 0.5 % and Residual elements 2%).
Carriage bolts	1.27 X 19.1 cm	26 units	Low alloy carbon steel MSDS=(Iron 99%, Carbon 1%, Manganese 2% Silicone 0.5% Chromium 0.5 % and Residual elements 2%).
Vexar black polyethylene netting	1.27 cm mesh	150 sq. ft.	Carbon black is fully bound in polymer and therefore cannot exhibit its characteristic toxicity MSDS=(Polyethylene resins > 90% and Carbon black <2.5 %

Table 2 Water quality results from samples taken near the domestic water intake, Campbellton River, 1972 to 2000 (Wight 1995).

		Date of collection							
Parameter	Units	July, 1972	July, 1973	20-Oct-87	18-Jun-90	14-Nov-90	13-Jun-94	08-Nov-94	31-Jul-00
Alkalinity	mg/L $CaCO_3$	6.0	6.0	9.5	8.8	9.9	6.0	6.3	7.6
Apparent colour	TCU			15	44	42	40	37	
Hardness	mg/L CaCO3	8.0	7.0						7.4
Kjeldahl nitrogen	mg/L N			0.22	0.25	0.30	0.20	0.28	
Nitrate(+ nitrite)	mg/L N			0.008	0.002	0.027	<0.004	0.013	<0.005
pH	Units	6.84	6.7		6.62	6.61	6.57	6.75	7.14
Total Phosphorus	mg/L PO_4			0.026	0.030	0.16	0.0025	0.0025	<0.01
Specific Conductance	Micromhos/cm	20.0	23.0	40.0	21.2	34.2	19.3		38.5
Turbidity	NTU	0.35	0.8	0.60	0.36	0.28	0.55	0.21	0.23
Calcium	mg/L Ca		1.5	2.90	2.16	2.98	1.69	2.35	2.20
Magnesium	mg/L Mg			0.79	0.50	0.76	0.47	0.65	0.47
Manganese	mg/L Mn			0.01	0.02	0.01	0.014	0.004	<0.01
Iron	mg/L Fe			0.05	0.07	0.060	0.013	0.052	<0.01
Copper	mg/L Cu			0.005	0.003	0.003	0.0005	0.004	<0.01
Zinc	mg/L Zn			0.005	0.02	0.01	0.001	0.002	<0.01
Cadmium	mg/L Ca			0.0003	0.0003	0.0003	0.00025	0.00025	
Lead	mg/ Pb			0.0005	0.005	0.0005	0.0005	0.0005	
Chloride	mg/L Cl	3.0	3.0	6.00	2.70	3.60	2.90	3.70	3.7
Sodium	mg/L Na			3.4	2.88	2.51	1.72	2.2	2.68
Potassium	mg/L K			0.52	0.32	0.33	0.3	0.1	0.24
Aluminium	mg/L Al			<0.025	0.01	0.025	0.039	0.047	
Chromium	mg/L <0.005			0.0025	0.0025	0.0025	0.00068	0.0005	
Nicklel	mg/L Ni			0.005	0.0025	0.0025	0.0016	0.001	
Flouride	mg/L F			0.06	0.03	0.06	0.025	0.025	<0.01
Sulfate	mg/L SO_4			3.3	1.8	3.0	1.1	1.3	0.8
Total Dissolved Solids	mg/L			46	35	44	18	21	25
Total suspended Solids	mg/L			<4	<4	<4	<4	<4	<2
Total Organic Carbon	mg/L C						1.7	4.5	3.2
Arsenic	mg/L As			0.0025	0.0025	0.0025			

Table 3. Water quality data collected by the Department of Environment and Lands at 3 sites, Campbellton River, 1992.

	Site 1						Site 2						Site 3					
Date	Apparent color	pH	Specific conductance	Turbidity	Total dissolved solids	Total suspended solids	Apparent color	pH	Specific conductance	Turbidity	Total dissolved solids	Total suspended solids	Apparent color	pH	Specific conductance	Turbidity	Total dissolved solids	Total suspended solids
	TCU	Units	Micromhos/cm	NTU	mg/L	mg/L	TCU	Units	Micromhos/cm	NTU	mg/L	mg/L	TCU	Units	Micromhos/cm	NTU	mg/L	mg/L
11-May	45	6.62	25.3	0.25	30	<4	46	6.62	25.3	0.36	26	<4	43	6.64	24.9	0.24	29	<4
11-Jun	48	6.73	25.0	0.41	24	<4	47	6.71	24.4	0.43	24	<4	48	6.73	24.8	0.40	27	<4
2-Jul	42	6.71	27.6	0.77	20	<4	42	6.71	26.2	0.81	23	<4	41	6.72	26.8	0.80	19	<4
8-Jul	52	6.72	26.9	0.68	21	<4	52	6.72	26.0	1.58	20	<4	47	6.79	29.2	0.83	20	<4
5-Aug	41	6.81	27.9	0.33	18	<4	40	6.81	27.9	0.20	19	<4	40	6.76	27.7	0.48	19	<4
18-Aug	38	6.89	28.1	0.21	19	<4	38	6.89	28.0	0.27	19	<4	39	6.90	30.7	0.36	19	<4
21-Aug	41	6.79	27.1	0.71	18	<4	49	6.90	28.4	0.82	29	<4	43	6.90	28.7	0.72	32	<4
25-Aug	34	6.83	26.9	0.75	18	<4	33	6.79	26.1	0.64	17	<4	30	6.85	27.1	0.34	18	<4
1-Sep	30	6.95	27.5	0.33	18	<4	31	6.85	26.9	0.67	18	<4	30	6.96	26.6	0.48	18	<4
8-Sep	35	6.99	27.8	0.43	19	<4	31	6.97	27.9	0.71	19	<4	33	6.92	29.3	0.50	20	<4
16-Sep	34	6.89	28.0	0.42	19	<4	51	6.94	27.9	0.51	19	<4	42	6.92	27.7	0.38	18	<4
15-Oct	43	6.58	32.3	0.75	22	<4	43	6.63	31.5	0.75	21	<4	48	6.61	32.8	0.77	22	<4
12-Nov	39	7.00	29.2	0.16	19	<4	39	6.84	28.3	0.12	19	<4	37	6.86	28.1	0.17	19	<4
Mean	40.2	6.8	27.7	0.5	20.4	<4	41.7	6.8	27.3	0.6	21.0	<4	40.1	6.8	28.0	0.5	21.5	<4

Site 1 Water samples taken 20 meters above the steel bridge located 5.4 km upstream that crosses Campbellton River.

Site 2 Water samples taken 35 meters below the steel bridge 5.4 km upstream that crosses Campbellton River.

Site 3 At the river mouth near the water supply intake for the Community of Campbellton.

Table 4 Water chemistry results from three sites, collected in August during a electro-fishing in the Campbellton River, 1993.

Parameter	Units	Water sampling collection sites		
		Neyles Brook	Indian Arm Brook	Island Pond Tributary
		27-Aug	28-Aug	30-Aug
PH		6.68	6.59	6.87
Gran Alkalinity	mg/L $CaCo_3$	6.46	6.19	12.83
Conductivity	uMHO/CM	24.3	22.7	38.1
Chloride	mg/L	2.38	2.17	3.18
Magnesium, dissolved	mg/L	0.545	0.570	1.005
Hardness, total	mg/L	7.58	7.57	14.00
Phosphate ortho	mg/L	<0.01	<0.01	<0.01
Phosphate total	mg/L	<0.02	<0.02	<0.02
Nitrogen - Nitrate	mg/L	0.031	<0.008	<0.008
Sulphate	mg/L	0.81	0.94	0.72
Calcium dissolved	mg/L	2.14	2.09	3.96
Turbidity	NTU	1.6	1.6	1.7
Colour	Rel. Units	30	30	40

Table 5. Water quality parameters collected downstream of adult fence using a LaMotte Freshwater sampling Kit (AQ-2). Campbellton River, 2001.

Date		Ph	Ammonia Nitrogen (ppm)	Nitrite Nitrogen (ppm)	Alkalinity $CaCO_3$ (ppm)	Carbon Dioxide (ppm)	Chloride (ppm)	Hardness (ppm)	Oxygen (ppm)
3-May	*	6.50	0.4	0.05	16			5	
19-Jun		6.50	0.3	0.05	22	5	18	18	8.3
29-Aug		6.75	0.2	0.05	20	16	16	16	8.2
11-Oct	*	6.50	0.2	0.05	18	4	20	30	

* The results for these water samples represent water quality when the counting fences were not in the water.

Table 6. Water quality results from 17 rivers in Notre Dame Bay, Newfoundland, collected in 1972 and 1973 (Jamieson 1974)

River	Date Collected	PH	Total Hardness	Specific conductance	Turbidity (JTU)	Total Alkalinity ppm	Calcium ppm	Chloride ppm	Hco3 bicarbonate
Birchy Bay Brook	Jul-73	7.50	13.0	37	0.90	10.0	3.8	4.0	12.2
Barry Brook (Gander R.)	Jul-73	6.60	7.0	29	1.00	2.0	1.2	5.0	2.4
Eel Brook, Norris Arm	Jul-73	6.75	9.0	25	0.75	6.5	2.2	3.1	8.0
Exploits River above Grand Falls	May-73	5.80	6.0	19	1.00	3.0	1.9	2.5	3.7
Gander River at Glenwood	Aug-72	6.50	8.0	24	2.20	4.0	1.2	4.0	4.9
Gander Bay Brook (Gander Bay)	Jul-73	6.45	16.0	110	1.20	8.0	2.8	25.5	9.8
Horward River	Jul-73	6.95	7.0	28	1.00	6.0	1.9	4.0	7.3
Jumpers Brook (Exploits R.)	Aug-72	7.20	16.0	33	0.70	12.0	1.8	3.5	14.6
Little Rattling Brook	Aug-72	6.90	11.0	31	0.66	8.0	1.6	2.5	9.8
South West Brook (Lewisporte)	Jul-73	6.90	18.0	35	0.90	9.0	2.2	5.0	10.9
Loon Bay Brook	Jul-73	6.95	8.0	28	1.00	7.0	2.5	3.5	8.5
Migells Brook (N.W. Gander)	Jun-73	5.80	4.0	14	1.30	2.0	0.9	2.0	2.4
North Arm River (Bay of Exploits)	Aug-72	6.78	8.0	23	0.50	6.0	1.8	3.5	7.3
Ragged Hr. River	Jul-73	6.70	7.0	28	0.90	5.0	1.2	5.0	6.1
Soulis Brook	Aug-72	6.68	6.5	23	0.75	3.5	1.5	4.0	4.3
Salmon River (near Gander)	Aug-72	7.04	7.0	19	0.05	6.0	1.4	2.6	7.3
West Brook	Aug-72	6.80	9.3	22	1.84	7.3	1.3	2.3	8.9
Mean		6.72	9.46	31.06	0.98	6.19	1.84	4.82	7.55
Max		7.5	18	110	2.2	12	3.8	25.5	14.6
Min		5.8	4	14	0.05	2	0.9	2	2.44
STD		0.43	3.99	21.21	0.49	2.78	0.72	5.41	3.38

Table 7. Comparsions of water chemistry at sites above and below the counting fences in 2001 and probabilities (p) of an effect due to sampling date and site value of < 0.05 indicates a significant effect. Group means are concentrations from all samples from above or below the counting fence. Guideline values are from the Canadian water quality guidelines for the protection of aquatic life – freshwater (Canadian Council of Ministers of the Environment 2001). Blank cells indicate no guideline value given.

Element	Effect		Group means (ug/L)		Guideline
	Date (p)	Site (p)	Above	Below	values (ug/L)
K	<0.001	0.978	271	271	
Na	<0.001	0.239	3235	3259	
Li	<0.001	0.329	0.32	0.32	
Mg	<0.001	0.213	702	710	
Al	<0.001	0.76	49	49	5-100
Ca	<0.001	0.934	1683	1684	
Si	<0.001	0.77	932	963	
V	<0.001	0.163	0.19	0.18	
Cr	<0.001	0.114	0.33	0.35	1
Mn	<0.001	0.12	12.7	12.4	
Fe	<0.001	0.77	67.4	67.2	300
Co	<0.001	0.303	0.03	0.03	
Ni	<0.001	0.367	0.2	0.18	25
Cu	0.822	0.966	0.57	0.55	2
Zn	0.62	0.166	5.24	2.7	30
As	<0.001	0.105	1.01	1	5
Sr					
Mo	0.053	0.259	0.42	0.32	73
Cd	<0.001	0.804	0.05	0.04	0.006
Ba					
Pb	0.013	0.438	0.12	0.08	1

Table 8. Comparison of historical water quality data from Tables 4,5,6 and 7 with data 2001.

Element	Range (ug/L)	
	Years 1973 to 2000	Year 2001
Ca	1690 – 2980	1082 - 2713
Mg	470 - 790	507 - 1040
K	100 - 520	231 - 317
Pb	0.5	0 – 0.66
Cu	0.5 – 4.0	0.21 - 2.0
Zn	1 - 20	0 - 12

Table 9. Bacteriological water analysis for Campbellton River,

Dat	Upstream from the		Downstream from the	
	Total coliforms (per	E-coli (per 100	Total coliforms (per	E-coli (per 100
3- *	44	9	24	8
6-	33	0	85	0
20-	98	2	140	1
24-	>80	3	>80	2
14-	>80	0	>80	0
29-	>80	4	>80	4
16- *	>80	1	>80	0

* Water samples were taken when the counting fences

Appendix 1 (a,b&c)

The following are the Material Safety Data Sheets for the major components used in a portable conduit fish counting fence. These MSDS were supplied from the manufactures for the components used in the counting fence.

Appendix 1a (Vexar Netting)

The MSDS format adheres to the standards and regulatory requirements of Canada and may not meet regulatory requirements in other countries.

DuPont Page 1 Material Safety Data Sheet

VEXAR BLACK POLYETHYLENE NETTING
VEXAR010 Revised 19-JUL-2000

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Product Use
Finished product
Packaging Agent
Tradenames and Synonyms
H-5, H-13, H-35, H-50, H-51, H-52, H-80, H-81, H-83, H-84, L-201, L-1, L-3, L-8, L-21, L-29, L-30, L-31, L-32, L-34, L-36, L-37, L-38, L-45, L-65, L-70, L-77, L-300, L-250, CE121, CE131, E-1553,
DUPONT POLYETHYLENE NETTING
ALL THE ABOVE GRADES IN BLACK.
"VEXAR" is a Registered Trademark of Enhance Packaging Technologies Inc.
Company Identification
MANUFACTURER/DISTRIBUTOR
Enhance Packaging Technologies Inc.
(A DuPont Canada Company)
201 South Blair Street
Whitby, Ontario
L1N 5S6
PHONE NUMBERS
Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 hours)
Medical Emergency : 1-613-348-3616 924 hours)

COMPOSITION/INFORMATION ON INGREDIENTS

Components
Material CAS Number %
Polyethylene Resins 9002-88-4 >90 WT%
Carbon Black 1333-86-4 <2.5 WT%
Components (Remarks)
Carbon black is fully bound in polymer and therefore cannot exhibit its characteristic toxicity..VEXAR010 DuPont Page 2

Material Safety Data Sheet

HAZARDS IDENTIFICATION

Potential Health Effects

INHALATION

Not a probable route of exposure.

SKIN CONTACT

No adverse effects expected from skin contact.

EYE CONTACT

No adverse effects expected - mechanical irritant only.

INGESTION

Not a probable route of exposure. Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens.

Material IARC NTP OSHA ACGIH

Carbon Black 2B

FIRST AID MEASURES

No Information Available

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : ~350 C (~662 F)

Method : ASTM D1929.

Extinguishing Media

Use any available extinguishing media..VEXAR010 DuPont Page 3

Material Safety Data Sheet

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate

PERSONAL PROTECTIVE EQUIPMENT during clean-up.

HANDLING AND STORAGE

No Information Available

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Provide local ventilation if processing is carried out at high temperatures.
 # Exposure Guidelines
Applicable Exposure Limits
Polyethylene Resins
PEL (OSHA) : None Established
TLV (ACGIH) : None Established
AEL * (DuPont) : 10 mg/m3, 8 & 12 Hr. TWA, total dust
5 mg/m3, 8 & 12 Hr. TWA, respirable dust
Carbon Black
PEL (OSHA) : 3.5 mg/m3, 8 Hr. TWA
TLV (ACGIH) : 3.5 mg/m3, 8 Hr. TWA, A4
AEL * (DuPont) : 0.5 mg/m3, 8 & 12 Hr.TWA, (Polynuclear Aromatic Hydrocarbon Content <0.1%)
Includes Channel, Lamp, and Thermal Black
*** AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.**

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data
Melting Point : 110-130 C (230-266 F)
Solubility in Water : 0 %
Density : <1 g/cm3.VEXAR010 DuPont Page 4
Material Safety Data Sheet

STABILITY AND REACTIVITY

Chemical Stability
Stable.
Incompatibility with Other Materials
None reasonably foreseeable.
Decomposition
Decomposes with heat. Hazardous gases or vapors can be released, including acrolein, carbon dioxide, carbon monoxide.
Polymerization
Polymerization will not occur.

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information
AQUATIC TOXICITY:
No information. Toxicity is expected to be negligible due to lack of solubility in water.

DISPOSAL CONSIDERATIONS

Waste Disposal
Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations.

TRANSPORTATION INFORMATION

Shipping Information
DOT
Proper Shipping Name : NA
Hazard Class : Not Regulated.VEXAR010 DuPont Page 5
Material Safety Data Sheet
(TRANSPORTATION INFORMATION - Continued)
Shipping Information -- Canada
This material is Not Regulated.

REGULATORY INFORMATION

Canadian Regulations
This is not a WHMIS Controlled Product.

OTHER INFORMATION

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.
Responsibility for MSDS
---------- PRODUCT STEWARD Enhance Packaging Technologies Inc. (A DuPont Canada Company) 201 South Blair Street Whitby, Ontario L1N 5S6 Phone: (905) 666-7026.
 # Indicates updated section.This information is based upon technical information believed to be reliable. It is subject to revision as additional knowledge and experience is gained. End of MSDS

Appendix 1b (Zinc Plated Carbon Steel Tubes)

Manufacturer:	Information & Emergency Telephone Numbers
Columbia MBF 7555 Tranmere Drive Mississauga, Ontario Canada, L5S 1K4 Telephone: (905) 678 - 9191 Fax: (905) 678 - 9323	Columbia MBF 7555 Tranmere Drive Mississauga, Ontario Canada, L5S 1K4 Telephone: (905) 678 - 9242 x.242 Fax: (905) 678 - 9323

Section I - Material Identification And Use

Material Name / Identifier
Zinc plated carbon steel tube

WHIMIS Class
D2A

Chemical Name
Not Applicable

Chemical Family
Steel

Chenical Formula
Not Applicable

Molecular Weight
Not Applicable

Trade Name and Synonyms
Not Applicable

Material Use
Conduit Used in Construction

Section II - Hazardous Ingredients Of Material

Element	% Max.	C.A.S. NO.	T.L.V. (A.C.G.I.H.) mg/m3(as Fumes)	P.E.L. (OSHA) mg/m3(as Fumes)	LD50/LC50
Steel / Zinc Plated					
Iron	98.3	7439-89-6	5	10	30gm/kg(LD50 Oral Rat)
Manganese	0.95	7439-96-5	1	5	9 gm/kg (LD50 Oral Rat)
Nickel	0.0005	7440-02-0	1	1	Not Available
Chromium	0.001	7440-47-3	0.5	1	Not Available
Zinc	3	7440-66-6	5	5	Not Available

Note: **The above ingredient list identifies those components which meet the regulated reporting criteria. Concentration represents a maximum for all the grades within a category of steel products and must not be interpreted as a specification for a particular grade.**

Coating: Zinc coating may be chemically passivated with a chromium compound and a water soluble corrosion inhibitor.

Section III - Physical Data For Steel

Physical State
Solid Solid

Odour and Apperance
Silver/Grey Metallic

Odour Threshold
Not Applicable

Vapour Pressure (mm)
Not Applicable

Vapour Density(air = 1)
Not Applicable

Boiling Point
Not Applicable

Solubility in Water (20 C)
Not Applicable

% Volitile(by volume)
Not Applicable

Evaporation Rate
Not Applicable

ph
Not Applicable

Specific Gravity
7.6 - 7.8

Freezing/Melting Point(0 C)
1530 C (Steel)

Section IV - Fire Explosion Hazard Of Material

Flammability
Not Flammable

Means of Extinction
Not Applicable

Hazardous Combustion Product
Not Applicable

Flashpoint (0 C) and Method
Not Applicable

Upper explosive limit (% by Volume)
Not Applicable

Auto Ignition Temperature (0C)
Not Applicable

Lower explosive limit (% by Volume)
Not Applicable

Explosion Data - Sensitivity to Chemical Impact
Not Applicable

Sensitivity to Static Discharge
Not Applicable

Special Procedures
Not Applicable

Rate Of Burning
Not Applicable

Section V - Reactivity Data

Chemical Stability
Yes

Reactivity and under what conditions
Contact witth mineral acids will release hydrogen gas

Incompatibility to other substances
Not Applicable

Hazardous Decomposition Products
Thermal degradation of coating materials (if any) may produce irritating hydrocarbons, at temperatures aboue the melting point of the coating, galvanized pipe may liberate zinc fumes, carbon monoxide and oxides of nitrogen

Section VI - Toxicological Properties Of Product

Effects of Acute Exposure to Product
Welding or burning of material will generate metal fumes. Inhalation overexposure to fume may cause a flu-like condition (e.g. chills/nausea) called metal fume fever. Eye irritation may result from contact with coating.

Effects of Chronic Exposure to Product
Welding, burning or grinding will generate metal fumes or dust. Prolonged inhalation overexposure to dust or fumes may result in the accumulation of iron oxide in the lung: a condition (siderosis) with few or no symptoms. Certain nickel and chromium compounds have been listed by IARC as nasal and lung carcinogens.

Sensitization to Product
No known effect

Synergistic materials
No known effect

Reproduction effects
No known effect

Teratogenicity
No known effect

Mutagenicity
No known effect

Section VII - Preventive Measures

Personal Protective Equipment

Personal protective equipment required is dependent upon the process or operation being performed on the material (e.g. burning, welding)
Each operation must be addressed for suitable protective equipment required.

Gloss (Specify)
Leather faced or equivalent

Eye (Specify)
Safety glasses or facesheild as appropriate

Footware (Specify)
Safety shoes or boots where required

other (Specify)
None

Respiratory
NIOSH approved respiratory protection where appilvable

Engineering Controls (e.g. ventilation, enclosed process, specify)
General or Local ventilation during welding, burning or grinding

Leak and Spill Procedure
Not Applicable

Wate Disposal
Not Applicable

TDG Classification
Not Regulated

Section VIII - First Aid Measures

Skin
Wash affected area with soap and water. Seek medical attention if irritation persists.

Eye
For irritation from any coating material, flush eyes with plenty of water while holding eyelids open. Seek medical attention if irritation persists.

Inhalation
For overexposure to metal fumes, remove to fresh air. Seek medical attention for adverse symptoms.

Ingestion
Not Applicable

Section IX - Disclaimer And Limitation Of Liability

While Columbia MBF believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the test conducted. The data are not to be taken as warranty or representation for which Columbia MBF assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Final determination of the suitability if the material for the use contemplated, the manner of use, and whether the suggested use infringes any patent is the sole responsibility of the buyer.

Section X - Confidentiality Clause

It is agreed and understood that the information supplied herein is the property of Columbia MBF and is not to be divulged in any manner whatsoever by the customer nor by anyone acting on behalf of the customer to anyone and the customer shall be responsible for any loss suffered by Columbia MBF if the information is divulged to anyone.

Section XI - Preparation Date Of M.S.D.S.

Prepared By:	**Phone No.**	**Fax No.**	**Revised**
Safety Department	(905) 678 - 9191	(905) 678 - 9323	February 8th, 2002

Appendix 1c (Low Carbon Steel)

SECTION I: HAZARDOUS INGREDIENTS

Chemical Identity	Concentration	CAS Number	PIN Number	LD_{50}	LC_{50}
Iron and Iron Oxides	97 to 99 percent	7439-89-6	1376	30 g/kg Oral - Rat	Not Available
Nickel	0.1 to 0.5 percent	7440-02-0	Not Available	Not Available	Not Available
Chromium	0.1 to 0.7 percent	7440-47-3	Not Available	Not available	Not Available

SECTION II: PREPARATION INFORMATION

Prepared By:	Bruno Mannella, B.Sc.
Company:	Gerdau Courtice Steel Inc.
Address:	160 Orion Pl., P.O. Box 1734, Cambridge, ON, N1T 1R9
Phone Number:	(519) 740 2488
Fax Number:	(519) 740 2601
Date of Preparation:	26 February 2001

SECTION III: PRODUCT INFORMATION

Product Identifier:	Steel
Manufacturer's Name:	Gerdau Courtice Steel Inc.
Address:	160 Orion Pl., P.O. Box 1734, Cambridge, ON, N1T 1R9
Emergency Phone Number:	(519) 740 2488
Fax Number:	(519) 740 2601
Supplier's Name:	Gerdau Courtice Steel Inc.
Address:	160 Orion Pl., P.O. Box 1734, Cambridge, ON, N1T 1R9
Emergency Phone Number:	(519) 740 2488
Fax Number:	(519) 623 2062
Product Use:	Product of Steel Production

SECTION IV: PHYSICAL DATA

Physical State:	Solid
Odour and Appearance:	Odourless. Dark gray solid.
Odour Threshold:	Not Applicable
Specific Gravity (water=1):	Not available for mixture (5.12 to 5.24 for Iron or Iron Oxides)

Co-efficient of Water/Oil Distribution:	Not Applicable
Vapour Pressure:	Not Applicable
Melting Point (°C):	1000 to 1500 degrees Celsius
Boiling Point (°C):	2600 to 3000 degrees Celsius
pH:	Not Applicable
Vapour Density (Air=1):	Not Applicable
Evaporation Rate (BuAc=1):	Not Applicable
Percent Volatile (by volume):	Not Applicable

SECTION V: FIRE/EXPLOSION HAZARD

Conditions of Flammability:	Not Applicable
Means of Extinction:	Not Applicable
Explosion Data:	Not Applicable
Sensitivity to Mechanical Impact:	Not Available
Sensitivity to Static Discharge:	Not Available
Flashpoint (°C) and Method:	Non-combustible
Upper Flammable Limit %:	Not Applicable
Lower Flammable Limit %:	Not Applicable
Autoignition Temperature (°C):	Not Applicable
Hazardous Combustion Products:	Non-combustible

SECTION VI: REACTIVITY DATA

Stability:	Stable under normal use conditions.
Incompatible Materials:	See Conditions of Reactivity
Conditions of Reactivity:	As with other metals, iron becomes more reactive as it is more finely divided. Ultrafine iron powder is pyrophoric and potentially explosive. Explosive or violent reaction with ammonium nitrate + heat, ammonium peroxodisulfate, chloric acid, chlorine triflouride, chloroformamidinium nitrate, bromine pentafluoride + heat (with iron powder), air + oil (with iron dust), sodium acetylide. Ignites on contact with chlorine, dinitrogen tetraoxide, liquid fluorine, hydrogen peroxide (with iron powder), nitryl fluoride + heat, peroxyformic acid, potassium perchlorate, potassium dichromate, sodium peroxide (at 240°), polystryene + friction or spark (iron powder). Mixtures of iron dust with air + water may ignite on drying. Addition of water to molten steel may result in explosion.
Hazardous Decomposition Products:	Fumes of iron oxide, nickel and chromium (trivalent and hexavalent compounds) oxides may be generated by manufacturing processes (e.g. welding, cutting, heating etc.).

SECTION VII: TOXICOLOGICAL PROPERTIES

Route of Entry:	☐ Skin Contact ☐ Skin Absorption ☒ Eye Contact ☒ Inhalation ☐ Ingestion
Effects of Acute Exposure to Product:	Dust particles may irritate the eyes and cause coughing and mild temporary irritation. Allergic contact dermatitis (skin reddening, swelling) may occur with skin contact with nickel or hexavalent chromium compounds (ACGIH).
Effects of Chronic Exposure to Product:	NOTE: Product is a solid mass; warnings are based on inhalation of dust or fume emissions that are possible during manufacturing or chemical reactions. NOTE: When exposure concentrations of dust generated by manufacturing processes are kept below applicable occupational exposure limits, the following health effects should not occur. Iron: Chronic exposure (ie. inhalation of iron dust or fume) can cause a benign pneumoconiosis called "Siderosis". Nickel: Chronic exposure (ie. inhalation of nickel dust or fume) can cause asthma, and pulmonary edema in welders using nickel alloys (ACGIH). Chromium: Dermatitis has been reported in workers handling trivalent chromium compounds (ACGIH). Chronic exposure (ie. inhalation of hexavalent chromium dust or fume) can cause skin ulcers and nasal irritation ranging from rhinitis to perforation of the nasal septum (ACGIH).
Exposure Limits:	Ontario Ministry of Labour 8-hour Time-Weighted Average Exposure Value (TWAEV) for iron-containing welding fume or particulate: 5 mg/m^3. Ontario Ministry of Labour 8-hour (TWAEV) for nickel metal and oxides: 1 mg/m^3. Ontario Ministry of Labour 8-hour (TWAEV) for chromium metal and divalent and trivalent compounds: 0.5 mg/m^3. Ontario Ministry of Labour 8-hour (TWAEV) for chromium hexavalent compounds: 0.05 mg/m^3.
Irritancy to Product:	Dust may irritate eyes, skin and nose.
Synergistic Products:	Not Available
Evidence of Carcinogenicity, Reproductive Toxicity, Teratogenicity or Mutagenicity:	Iron: Not classifiable as a human carcinogen: Inadequate data on which to classify the substance as a human and/or animal carcinogen (ACGIH). No information available regarding reproductive toxicity, teratogenicity or mutagenicity. Nickel: Not suspected as a human carcinogen: On the basis of properly conducted epidemiological studies in humans (ACGIH).

	Chromium (metal and trivalent compounds): **Not classifiable as a human carcinogen: Inadequate data on which to classify the substance as a human and/or animal carcinogen (ACGIH).**
Sensitivity to Product:	**Allergic contact dermatitis (skin reddening, swelling) may occur with skin contact with nickel or hexavalent chromium compounds (ACGIH).**

SECTION VIII: PREVENTATIVE MEASURES

Personal Protective Equipment:	**Yes, if engineering controls and work practices are not effective in controlling exposures below occupational exposure limits.**
Gloves (specify):	**Use of any gloves designed for protection against skin abrasion are recommended.**
Respiratory (specify):	**National Institute for Occupational Safety and Health (NIOSH) recommendations for iron oxide dust and fume concentrations in air:** **Up to 50 mg/m^3: dust, mist, and fume respirator; or SAR** **Up to 125 mg/m^3: SAR operated in a continuous-flow mode; or powered air-purifying respirator with dust, mist, and fume cartridges.** **Up to 250 mg/m^3: Full-facepiece respirator with high-efficiency particulate filter(s); or SAR with a tight-fitting facepiece operated in a continuous-flow mode; or powered air-purifying respirator with tight-fitting facepiece and high-efficiency particulate filter; or full-facepiece SCBA; or full-facepiece SAR.** **Up to 2500 mg/m^3: Positive pressure SAR.** **Emergency or planned entry into unknown concentrations or IDLH conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxillary positive pressure SCBA.** **Escape: Full-facepiece respirator with high-efficiency particulate filter(s); or escape-type SCBA.** **The respirator use limitations specified by the approving agency and the manufacturer must be observed.** **Recommendations apply only to NIOSH-approved respirators.** **NOTE: Respirator selection is based on iron oxide which is likely the most significant toxic constituent in the mixture (ie. based on the composition of the material).** **NOTE: The IDLH concentration for iron is 2500 mg/m^3.** **NOTE: SAR = supplied-air respirator; SCBA = self-contained breathing apparatus; IDLH = immediately dangerous to life and health.**
Eye (specify):	**Safety glasses with sideshields.**
Footwear (specify):	**Safety footwear when handling this material in bulk form**
Other Equipment (specify):	**Not applicable**
Engineering Controls (e.g. ventilation, enclosed process, specify):	**Use adequate general or local exhaust ventilation to keep fume or dust levels below occupational exposure limits.**
Leak and Spill Procedure:	**In the event of a spill or discharge, wear suitable protective clothing. Using a clean shovel, carefully place material into clean, dry container and cover; remove from area. Flush spill area with water.**
Waste Disposal:	**Dispose in accordance with all applicable Federal, Provincial, and local environmental regulations.**

Storage Requirements:	**See Conditions of Reactivity**

SECTION IX: FIRST AID MEASURES

Inhalation:	**If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.**
Ingestion:	**Not applicable**
Eye Contact:	**In case of contact, flush eyes with plenty of water for at least 15 minutes.**
Skin Contact:	**If irritation occurs, wash gently and thoroughly with water and non-abrasive soap. If irritation persists, obtain medical advice immediately.**

SOURCES USED

American Conference of Governmental Industrial Hygienists (ACGIH). ***Documentation of the Threshold Limit Values and Biological Exposure Indices, Sixth Edition.***

American Conference of Governmental Industrial Hygienists (ACGIH). ***Threshold Limit Values for Chemical Substances and Physical Agents*****, 2000**

Canadian Centre for Occupational Health and Safety (CCINFO). ***CHEMINFO for Iron Oxide, Nickel, and Chromium*****, December 2000.**

Lewis, Richard J. ***Sax's Dangerous Properties of Industrial Materials, Tenth Edition.***

Ontario Ministry of Labour (MOL). ***Ontario Regulation respecting Control of Exposure to Biological or Chemical Agents (O. Reg. 833).***